

CLAIMS

What is claimed is:

1 1. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a laser station that can weld the photonic package
5 components; and,

6 an automated handling assembly that can load and unload
7 the photonic package components in said laser station.

1 2. The machine of claim 1, wherein the photonic
2 package components include a package and a fiber sleeve
3 that are located in a horizontal position, said laser
4 station includes three lasers that weld the fiber sleeve to
5 the package.

1 3. The machine of claim 2, wherein said laser station
2 includes a package tooling that holds the package, said

3 package tooling having a yoke that can rotate about two
4 orthogonal axis.

1 4. The machine of claim 3, wherein said package tooling
2 includes an actuator to assert a biasing force to said
3 yoke.

1 5. The machine of claim 3, wherein said package
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 6. The machine of claim 3, wherein said package
2 tooling includes a friction band that can lock a position
3 of said yoke.

1 7. The machine of claim 6, wherein said package
2 tooling includes a vacuum channel that pulls said friction
3 band into said yoke.

1 8. The machine of claim 6, wherein said package
2 tooling has a vacuum channel that pulls said friction band
3 away from said yoke.

1 9. The machine of claim 3, wherein said package
2 tooling has a plurality of first electrical contacts that
3 can be coupled to the package, and an actuator that moves
4 said electrical contacts.

1 10. The machine of claim 9, wherein said package
2 tooling includes a plurality of second contacts that can be
3 coupled to said first contacts, and an actuator to move
4 said second contacts relative to said yoke.

1 11. The machine of claim 6, wherein said package
2 tooling includes a pair of rotary coupling that are pulled
3 into said yoke with a vacuum pressure.

1 12. The machine of claim 3, wherein said laser station
2 includes a fiber tooling that holds the fiber sleeve.

1 13. The machine of claim 12, wherein said fiber
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 14. The machine of claim 13, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

1 15. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 station means for laser welding the photonic package
5 components; and,

6 handling means for loading and unloading the photonic
7 package components in the station means.

1 16. The machine of claim 15, wherein the photonic
2 package components include a package and a fiber sleeve
3 that are located in a horizontal position, said station
4 means includes three lasers that weld the fiber sleeve to
5 the package.

1 17. The machine of claim 16, wherein said station
2 means includes a package tooling that holds the package,

3 said package tooling having a yoke that can rotate about
4 two orthogonal axis.

1 18. The machine of claim 17, wherein said package
2 tooling includes an actuator to assert a biasing force to
3 said yoke.

1 19. The machine of claim 17, wherein said package
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 20. The machine of claim 17, wherein said package
2 tooling includes a friction band that can lock a position
3 of said yoke.

1 21. The machine of claim 20, wherein said package
2 tooling includes a vacuum channel that pulls said friction
3 band into said yoke.

1 22. The machine of claim 20, wherein said package
2 tooling has a vacuum channel that pulls said friction band
3 away from said yoke.

1 23. The machine of claim 17, wherein said package
2 tooling has a plurality of first electrical contacts that
3 can be coupled to the package, and an actuator that moves
4 said electrical contacts.

1 24. The machine of claim 23, wherein said package
2 tooling includes a plurality of second contacts that can be
3 coupled to said first contacts, and an actuator to move
4 said second contacts relative to said yoke.

1 25. The machine of claim 17, wherein said package
2 tooling includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 26. The machine of claim 17, wherein said laser
2 station includes a fiber tooling that holds the fiber
3 sleeve.

1 27. The machine of claim 26, wherein said fiber
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 28. The machine of claim 27, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

1 29. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a first fixture that can hold first photonic package
5 component in a horizontal position;

6 a second fixture that can hold a second photonic
7 package component in a horizontal position adjacent to the
8 first photonic package component;

9 a first laser that can emit a light beam to weld the
10 first and second photonic package components;

11 a second laser that can emit a light beam to weld the
12 first and second photonic package components; and,

13 a third laser that can emit a light beam to weld the
14 first and second photonic package components.

1 30. The machine of claim 29, wherein the first
2 photonic package component is a package and the second
3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 31. The machine of claim 30, wherein said first
2 fixture has a yoke that can rotate about two orthogonal
3 axis.

1 32. The machine of claim 31, wherein said first fixture
2 includes an actuator to assert a biasing force to said
3 yoke.

1 33. The machine of claim 31, wherein said first
2 fixture includes a vibrator to apply vibratory energy to
3 said yoke.

1 34. The machine of claim 31, wherein said first
2 fixture includes a friction band that can lock a position
3 of said yoke.

1 35. The machine of claim 34, wherein said first
2 fixture includes a vacuum channel that pulls said friction
3 band into said yoke.

1 36. The machine of claim 35, wherein said first
2 fixture has a vacuum channel that pulls said friction band
3 away from said yoke.

1 37. The machine of claim 31, wherein said first
2 fixture has a plurality of first electrical contacts that
3 can be coupled to the package, and an actuator that moves
4 said electrical contacts.

1 38. The machine of claim 37, wherein said first
2 fixture includes a plurality of second contacts that can be
3 coupled to said first contacts, and an actuator to move
4 said second contacts relative to said yoke.

1 39. The machine of claim 34, wherein said first
2 fixture includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 40. The machine of claim 31, wherein said second
2 fixture includes an actuator to move the fiber sleeve into
3 the package.

1 41. The machine of claim 40, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

1 42. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 first fixture means for holding a first photonic
5 package component in a horizontal position;

6 second fixture means for holding a second photonic
7 package component in a horizontal position adjacent to the
8 first photonic package component;

9 first welding means for welding the first and second
10 photonic package components;

11 second welding means for welding the first and second
12 photonic package components; and,

13 third welding means for welding the first and second
14 photonic package components.

1 43. The machine of claim 42, wherein the first
2 photonic package component is a package and the second
3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 44. The machine of claim 43, wherein said first
2 fixture means includes a yoke that can rotate about two
3 orthogonal axis.

1 45. The machine of claim 44, wherein said first fixture
2 means includes an actuator to assert a biasing force to
3 said yoke.

1 46. The machine of claim 44, wherein said first
2 fixture means includes a vibrator to apply vibratory energy
3 to said yoke.

1 47. The machine of claim 44, wherein said first
2 fixture means includes a friction band that can lock a
3 position of said yoke.

1 48. The machine of claim 47, wherein said first
2 fixture means includes a vacuum channel that pulls said
3 friction band into said yoke.

1 49. The machine of claim 47, wherein said first
2 fixture means includes a vacuum channel that pulls said
3 friction band away from said yoke.

1 50. The machine of claim 44, wherein said first
2 fixture means includes a plurality of first electrical
3 contacts that can be coupled to the package, and an
4 actuator that moves said electrical contacts.

1 51. The machine of claim 50, wherein said first
2 fixture means includes a plurality of second contacts that
3 can be coupled to said first contacts, and an actuator to
4 move said second contacts relative to said yoke.

1 52. The machine of claim 44, wherein said first
2 fixture means includes a pair of rotary couplings that are
3 pulled into said yoke with a vacuum pressure.

1 53. The machine of claim 44, wherein said second
2 fixture means includes an actuator to move the fiber sleeve
3 into the package.

1 54. The machine of claim 53, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

1 55. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a first tooling that can hold a first photonic package
5 component in a horizontal position, said first tooling
6 having a yoke that can rotate about two orthogonal axis and
7 an actuator that applies a biasing force to said yoke;

8 a second tooling that can hold a second photonic
9 package component in a horizontal position adjacent to the
10 first photonic package component; and,

11 a laser that can emit a light beam to weld the first
12 and second photonic package components.

1 56. The machine of claim 55, wherein the first
2 photonic package component is a package and the second
3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 57. The machine of claim 55, wherein said first
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 58. The machine of claim 55, wherein said first
2 tooling includes a friction band that can lock a position
3 of said yoke.

1 59. The machine of claim 58, wherein said first
2 tooling includes a vacuum channel that pulls said friction
3 band into said yoke.

1 60. The machine of claim 58, wherein said first
2 tooling has a vacuum channel that pulls said friction band
3 away from said yoke.

1 61. The machine of claim 56, wherein said first
2 tooling has a plurality of first electrical contacts that
3 can be coupled to the package, and an actuator that moves
4 said electrical contacts.

1 62. The machine of claim 61, wherein said first
2 fixture includes a plurality of second contacts that can be
3 coupled to said first contacts, and an actuator to move
4 said second contacts relative to said yoke.

1 63. The machine of claim 55, wherein said first
2 tooling includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 64. The machine of claim 56, wherein said second
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 65. The machine of claim 64, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

1 66. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a first tooling that can hold a first photonic package
5 component in a horizontal position, said first tooling
6 having a yoke that can rotate about two orthogonal axis and
7 biasing means for applying a biasing force to said yoke;

8 a second tooling that can hold a second photonic
9 package component in a horizontal position adjacent to the
10 first photonic package component; and,

11 a laser that can emit a light beam to weld the first
12 and second photonic package components.

1 67. The machine of claim 66, wherein the first
2 photonic package component is a package and the second
3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 68. The machine of claim 66, wherein said first
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 69. The machine of claim 66, wherein said first
2 tooling includes a friction band that can lock a position
3 of said yoke.

1 70. The machine of claim 69, wherein said first
2 tooling includes a vacuum channel that pulls said friction
3 band into said yoke.

1 71. The machine of claim 69, wherein said first
2 tooling has a vacuum channel that pulls said friction band
3 away from said yoke.

1 72. The machine of claim 67, wherein said first
2 tooling has a plurality of first electrical contacts that
3 can be coupled to the package, and an actuator that moves
4 said electrical contacts.

1 73. The machine of claim 72, wherein said first
2 tooling includes a plurality of second contacts that can be
3 coupled to said first contacts, and an actuator to move
4 said second contacts relative to said yoke.

1 74. The machine of claim 66, wherein said first
2 tooling includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 75. The machine of claim 67, wherein said second
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 76. The machine of claim 75, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

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77. An automated laser weld machine that welds
together at least two photonic package components,
comprising:

a first tooling that can hold a first photonic package
component in a horizontal position, said first tooling
having a yoke that can rotate about two orthogonal axis and
a friction band that can lock and unlock said yoke;

a second tooling that can hold a second photonic
package component in a horizontal position adjacent to the
first photonic package component; and,

a laser that can emit a light beam to weld the first
and second photonic package components.

78. The machine of claim 77, wherein the first
photonic package component is a package and the second
photonic package component includes a fiber sleeve attached
to a fiber.

1 79. The machine of claim 77, wherein said first
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 80. The machine of claim 77, wherein said first
2 tooling includes a vacuum channel that pulls said friction
3 band into said yoke.

1 81. The machine of claim 77, wherein said first
2 tooling has a vacuum channel that pulls said friction band
3 away from said yoke.

1 82. The machine of claim 78, wherein said first
2 tooling has a plurality of first electrical contacts that
3 can be coupled to the package, and an actuator that moves
4 said electrical contacts.

1 83. The machine of claim 82, wherein said first
2 tooling includes a plurality of second contacts that can be
3 coupled to said first contacts, and an actuator to move
4 said second contacts relative to said yoke.

1 84. The machine of claim 77, wherein said first
2 tooling includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 85. The machine of claim 78, wherein said second
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 86. The machine of claim 85, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

1 87. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a first tooling that can hold a first photonic package
5 component in a horizontal position, said first tooling
6 having a yoke that can rotate about two orthogonal axis and
7 lock means for locking and unlocking said yoke;

8 a second tooling that can hold a second photonic
9 package component in a horizontal position adjacent to the
10 first photonic package component; and,

11 a laser that can emit a light beam to weld the first
12 and second photonic package components.

1 88. The machine of claim 87, wherein the first
2 photonic package component is a package and the second
3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 89. The machine of claim 87, wherein said first
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 90. The machine of claim 87, wherein said lock means
2 includes a friction band that is pulled into said yoke.

1 91. The machine of claim 90, wherein said lock means
2 includes a vacuum channel that pulls said friction band
3 away from said yoke.

1 92. The machine of claim 88, wherein said first
2 tooling has a plurality of first electrical contacts that
3 can be coupled to the package, and an actuator that moves
4 said electrical contacts.

1 93. The machine of claim 92, wherein said first
2 tooling includes a plurality of second contacts that can be
3 coupled to said first contacts, and an actuator to move
4 said second contacts relative to said yoke.

1 94. The machine of claim 87, wherein said first
2 tooling includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 95. The machine of claim 87, wherein said second
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 96. The machine of claim 95, wherein said actuator can
2 vary a force applied by the fiber sleeve to the package.

1 97. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a first tooling that can hold a first photonic package
5 component in a horizontal position, said first tooling
6 having a yoke that can rotate about two orthogonal axis, a
7 first plurality of contacts that can engage the package, a
8 second plurality of contacts, and an actuator that can move
9 said second plurality of contacts into said yoke so that
10 said second plurality of contacts are electrically coupled
11 to said first plurality of contacts;

12 a second tooling that can hold a second photonic
13 package component in a horizontal position adjacent to the
14 first photonic package component; and,

15 a laser that can emit a light beam to weld the first
16 and second photonic package components.

1 98. The machine of claim 97, wherein the first
2 photonic package component is a package and the second
3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 99. The machine of claim 97, wherein said first
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 100. The machine of claim 97, wherein said first
2 tooling includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 101. The machine of claim 98, wherein said second
2 tooling includes an actuator to move the fiber into the
3 package.

1 102. The machine of claim 101, wherein said actuator
2 can vary a force applied by the fiber sleeve to the
3 package.

1 103. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a first tooling that can hold a first photonic package
5 component, said first tooling having a yoke that can rotate
6 about two orthogonal axis, a first plurality of contacts
7 that can engage the package, and actuator means for
8 coupling a second plurality of contacts to said first
9 plurality of contacts;

10 a second tooling that can hold a second photonic
11 package component adjacent to the first photonic package
12 component; and

13 a laser that can emit a light beam to weld the first
14 and second photonic package components.

1 104. The machine of claim 103, wherein the first
2 photonic package component is a package and the second

3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 105. The machine of claim 103, wherein said first
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 106. The machine of claim 103, wherein said first
2 tooling includes a pair of rotary couplings that are pulled
3 into said yoke with a vacuum pressure.

1 107. The machine of claim 104, wherein said second
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 108. The machine of claim 107, wherein said actuator
2 can vary a force applied by the fiber sleeve to the
3 package.

1 109. An automated laser weld machine that welds
2 together at least two photonic package components,
3 comprising:

4 a first tooling that can hold a first photonic package
5 component, said first tooling having a yoke that can rotate
6 about a plurality of bearings, a friction band that locks a
7 position of said yoke with a vacuum pressure that also
8 moves and seals said bearings;

9 a second tooling that can hold a second photonic
10 package component adjacent to the first photonic component;
11 and,

12 a laser that can emit a light beam to weld the first
13 and second photonic package components.

1 110. The machine of claim 109, wherein the first
2 photonic package component is a package and the second
3 photonic package component includes a fiber sleeve attached
4 to a fiber.

1 111. The machine of claim 109, wherein said first
2 tooling includes a vibrator to apply vibratory energy to
3 said yoke.

1 112. The machine of claim 110, wherein said second
2 tooling includes an actuator to move the fiber sleeve into
3 the package.

1 113. The machine of claim 112, wherein said actuator
2 can vary a force applied by the fiber sleeve to the
3 package.

1 114. A method for welding a first photonic package
2 component to a second photonic package component,
3 comprising:

4 loading a first photonic package component onto a first
5 tooling with a robotic arm;

6 loading a second photonic package component onto a
7 second tooling with the robotic arm; and,

8 welding the second photonic package component to the
9 first photonic package component.

1 115. The method of claim 114, wherein the first and
2 second photonic package components are welded in a
3 horizontal position.

1 116. The method of claim 115, wherein the first and
2 second photonic package components are welded with three
3 lasers.

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